Dec. 6, 1960 W. M. PEAK ET AL 2,962,778

POURING CONTROL FOR ALUMINUM INGOTS

Filed Sept. 30, 1957 3 Sheets-Sheet 1

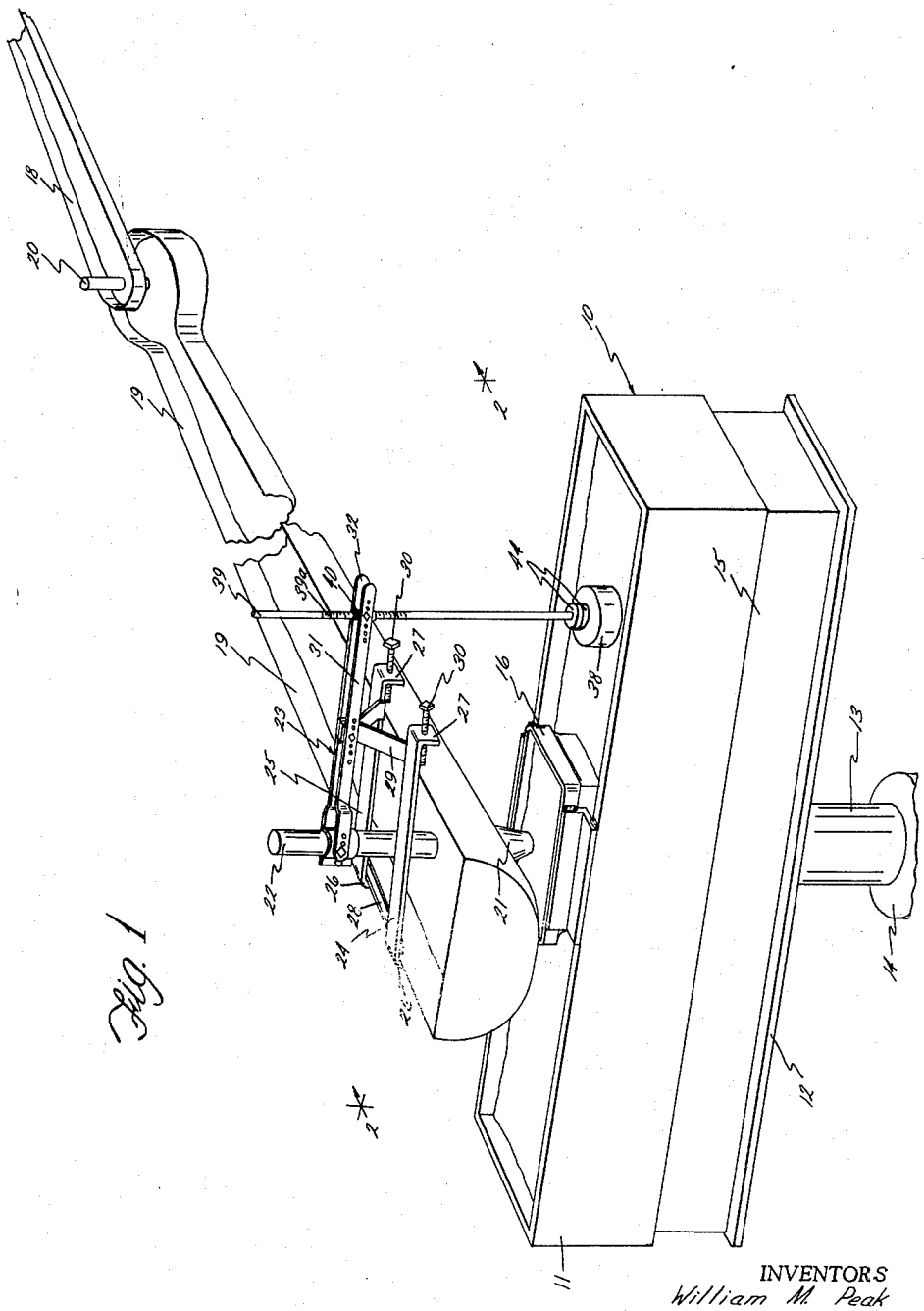


Fig. 1

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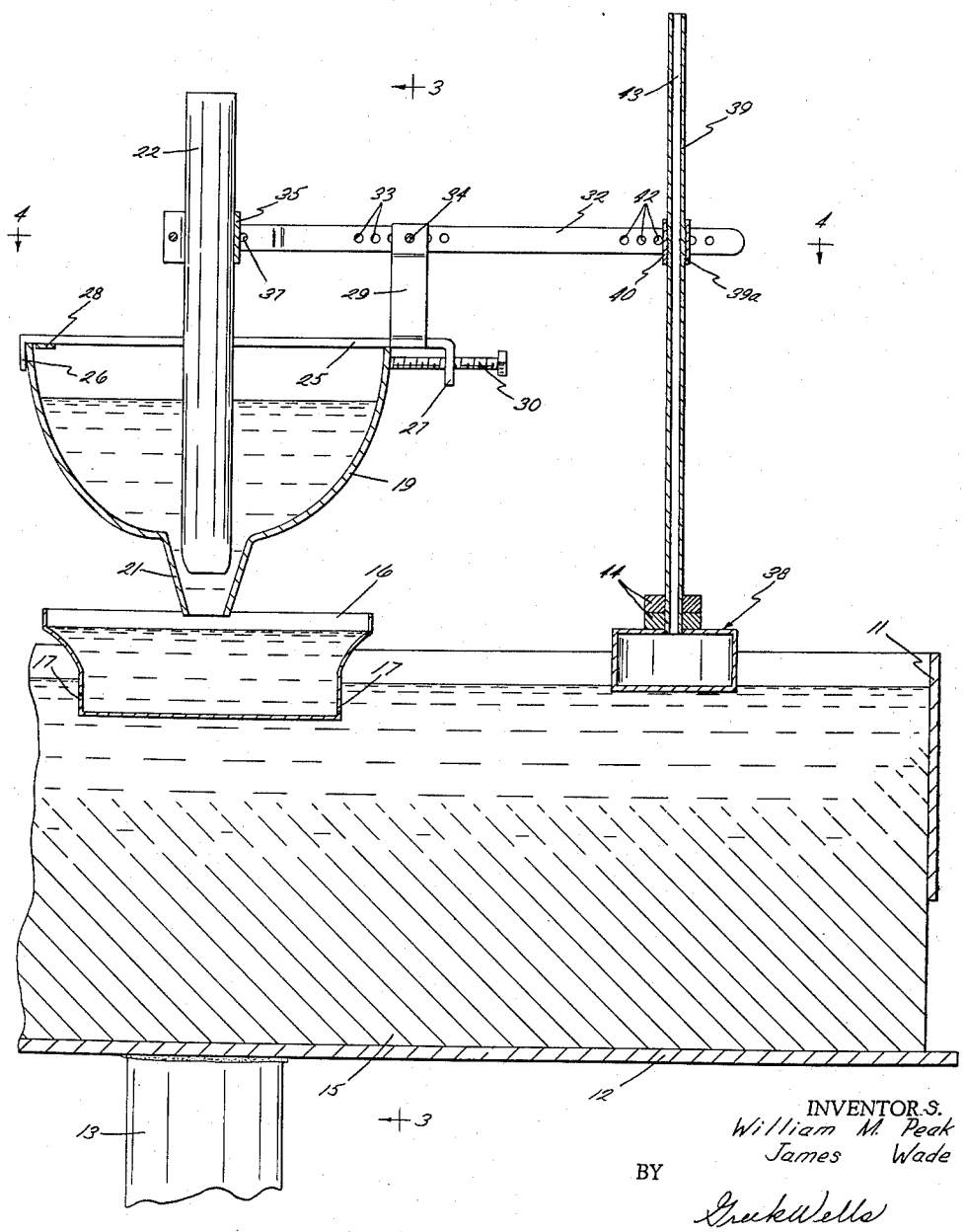
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Fig. 2



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Fig. 3

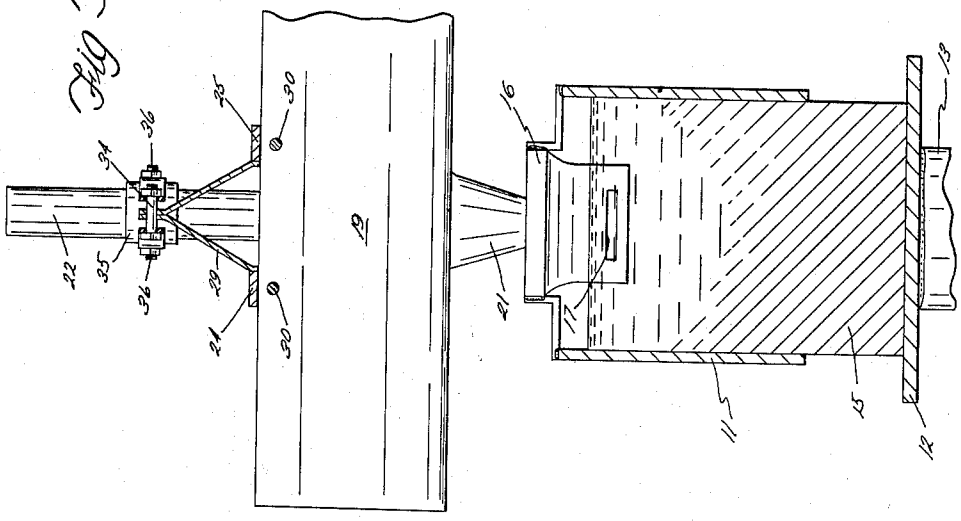
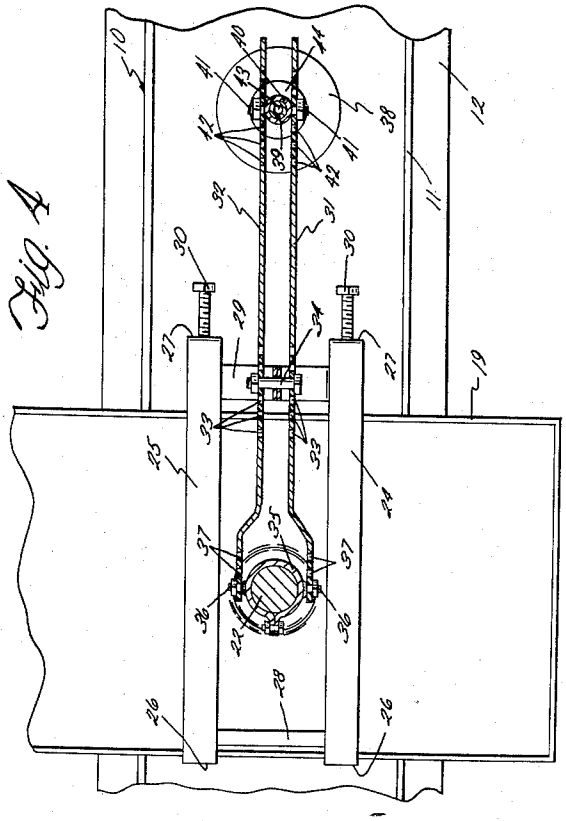


Fig. 4



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POURING CONTROL FOR ALUMINUM INGOTS

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3 Claims. (Cl. 22—79)

The present invention relates to improvements in means for controlling the flow of molten metal from a trough into an ingot mold.

In the manufacture of certain metal products such as sheet metal and the like, and particularly in the manufacture of sheet aluminum, one step of the manufacture process involves the formation or molding of large ingots of metal which are later rolled out into thin sheets. These ingots are formed by pouring molten metal into a mold and cooling it to a solid state. The formation of the ingot is a difficult and exacting process in that an acceptable ingot must be entirely homogeneous, and must be uniform throughout its mass in all respects.

One of the present methods of forming a commercially acceptable ingot is to utilize a vertically shallow four sided ring mold having an open top and an open bottom, together with a vertically movable bottom closure plate below the mold. The bottom closure plate is initially brought into position to close the bottom of the ring and molten metal is poured into the ring. As the metal is poured in the top of the ring, the bottom closure is lowered away at a constant rate. The lowering is timed so that the metal solidifies while confined within the ring mold and the solid ingot is withdrawn from the bottom thereof. By using this method it is possible to form ingots of very large dimensions which are homogeneous and uniform throughout their mass. This method successfully overcomes the problem of non-uniformity due to unequal cooling which is encountered in molding large objects by pouring molten metal into a stationary mold and allowing it to cool in the mold.

In carrying out the ingot molding process described above, it is essential that the flow of liquid into the ring mold be carefully controlled to maintain the liquid level in the mold stationary. If the flow of liquid is reduced, and the liquid level in the mold drops off, or if the flow of liquid is increased and the liquid level in the mold is allowed to rise, then the ingot withdrawn from the bottom of the mold will not be entirely uniform. It is the principal purpose of this invention to provide a control apparatus to control the flow of molten metal from a supply trough into the ring mold, to maintain the liquid in the ring mold at a constant level. More specifically it is the purpose of this invention to provide a novel and simple device for controlling the flow of molten metal from a supply trough into a mold which is operably responsive to the level of liquid in the mold to increase or decrease the flow of metal according to variations in the liquid level in the mold.

The nature and advantages of our invention will appear more clearly from the following description and the accompanying drawings wherein a preferred form of the invention is shown. It should be understood, however, that the description and drawings are illustrative only and are not intended to limit the invention except insofar as it is limited by the claims.

In the drawings:

Figure 1 is a perspective view illustrating an ingot mold, together with a molten supply trough, and illustrating our invention in place to control the flow of molten metal from the trough into the mold;

Figure 2 is an enlarged vertical sectional view taken substantially on the line 2—2 of Figure 1;

Figure 3 is a vertical sectional view taken on the line 3—3 of Figure 2; and

Figure 4 is a fragmentary sectional view taken substantially on the line 4—4 of Figure 2.

Referring now in detail to the drawings, we have shown, somewhat diagrammatically, an ingot mold, generally indicated by the numeral **10**, of the type currently in use in the aluminum industry for forming ingots of large dimensions. The mold **10** comprises a four sided ring **11**, the top and bottom of which are open, together with a horizontal bottom closure plate **12**, mounted on the piston **13** of an hydraulic cylinder **14**. The plate **12** is adapted to be moved up and down below the ring **11** by operation of the cylinder **14**.

In the formation of an ingot, such as that indicated by numeral **15**, the closure plate **12** is initially moved up against the bottom edge of the ring **11**, and molten aluminum is poured into the ring **11** from the open top. When the molten metal has reached a predetermined level in the ring **11**, the cylinder **14** is activated to commence lowering the closure plate away from the ring **11** at a predetermined steady rate. Molten aluminum is continuously poured into the top of the ring **11** at such a rate as to maintain the level in the ring **11** stationary. A box like baffle member **16**, having liquid discharge openings **17** at its ends, is suspended in the open top of the ring **11** to receive the molten metal poured into the top of the ring **11** and deflect it laterally toward the ends of the ring to insure that the ring is filled evenly. The rate at which the plate **12** is lowered is determined by the rate of cooling of the molten metal, and is adjusted so that a layer of metal poured into the ring **11** cools sufficiently during its downward movement through the ring **11** to substantially solidify while still confined within the ring **11**, so that as the closure plate **12** is lowered, a solid ingot is withdrawn from the bottom of the ring **11**.

The ring **11** may, of course, be cooled, and cooling means may be provided below the ring **11** to lower the temperature of the solid ingot, if desired. No such means have been shown in the drawings, since the details of construction and operation of the mold **10** form no part of the invention. Molds of the type hereinbefore described are well known in industry.

In order to convey molten metal from the furnace (not shown) wherein it is heated to a molten state to the mold **10**, trough means are provided. A supply trough **18** is provided into which molten aluminum is spilled from the furnace by some suitable means. The supply trough **18** has a delivery trough **19** connected thereto which carries the molten metal from the supply trough **18** to the mold **10**. As shown in Figure 1, the delivery trough **19** is pivotally connected to the supply trough **18** by pivot means **20** whereby to be pivoted laterally to serve several molds **10**.

It will be appreciated that maintenance of a constant liquid level in the ring **11** is of utmost importance in the formation of an acceptable ingot. If the level in the ring **11** is allowed to rise or fall because of improper adjustment of the rate of flow of metal from the trough **19**, a non-uniform ingot will be produced. It is therefore necessary to provide on the delivery trough **19**, means to regulate the flow of metal therefrom into the mold **10** in response to level variations in the ring **11**.

According to our invention, we accomplish this result by providing in the bottom of the trough **19** adjacent the discharge end thereof, a downwardly directed conical spout **21** adapted to pass molten metal from the trough downwardly into the baffle box **16** of the mold **10**. An upright cylindrical rod **22** is provided in the trough **19** in vertical alignment with the spout **21**. The rod **22** is smaller in diameter than the upper end of the spout **21** but greater in diameter than the lower end thereof so that it may be lowered into engagement with the conical wall of the spout **21** to close it. The bottom end of the rod **22** is rounded or bevelled as shown in Figure 2, to seal tightly against the spout **21** when it is lowered into engagement therewith. By moving the rod **22** vertically with respect to the spout **21** it is posible to accurately control the flow of molten metal from the trough **19** into the baffle box **16**.

To support the rod **22**, we provide a frame **23** which is adapted to be clamped to the trough **19** above the spout **21**. The frame **23** comprises a pair of spaced apart transversely extending members **24** and **25** which have their opposite ends turned downwardly as shown at **26** and **27**. The members **24** and **25** are connected together near one end by a bar **28**, and near the other end by an upstanding inverted V-shaped yoke **29**. The downturned ends **27** of the members **24** and **25** have clamping bolts **30** threaded therethrough. The frame **23** rests upon the trough **19** as shown best in Figure 1, with the members **24** and **25** extending across between the side walls thereof. The walls of the trough **19** are clamped between the downturned ends **26** of the members **24** and **25** and the bolts **30** and the frame **23** is thus held securely in place.

The upstanding inverted yoke **29** on the frame **23** pivotally supports a pair of control arms **31** and **32** which extend transversely over the frame **23**. As illustrated best in Figure 2, each of the control arms **31** and **32** has a series of apertures **33** near the center thereof, one of which receives a pivot pin **34** secured in the top of the yoke **29**. A split clamping sleeve **35** is positioned between the ends of the control arms **31** and **32** which extend over the trough **19**. The sleeve **35** has outwardly projecting pins **36** fixed thereon as shown in Figure 4, which extend through one of a series of holes **37** in the arms **31** and **32** to pivot the sleeve **35** between the ends of the arms **31** and **32**. The sleeve **35** is clamped around and supports the rod **22**. It will be understood that with this construction, movement of the control arms **31** and **32** about the pivot pin **34** results in vertical adjustment of the rod **22** with respect to the spout **21** and consequently, causes adjustment of the flow of molten metal therethrough.

In order to actuate the control arms **31** and **32** in response to level variations in the ring **11**, a float generally indicated at **38** is provided. The float **38** is connected to the lower end of a rod **39** which extends upwardly between the outer ends of the control arms **31** and **32**. The rod **39** has a threaded portion **39***a* thereon which receives a threaded sleeve **40**. The sleeve **40** is provided with pivot pins **41** which are journalled in one of a series of apertures **42** in the arms **31** and **32** to pivotally connect the float rod **39** to the arms **31** and **32**.

The operation of our invention is very simple. The float **38** is allowed to contact and be supported by the molten aluminum in the ring **11**. The float rod **39** and the rod **22** are then adjusted so that when the level in the ring **11** is at the proper point, the flow of molten metal through the spout **21** is just sufficient to maintain the level in the ring **11** constant as the closure plate **12** is lowered away. When these adjustments have been made, the apparatus will operate to maintain this level throughout the pouring operation. If for any reason, the level in the ring **11** tends to rise, the float **38** will be elevated, and this motion will be transmitted through

the rod **39** and the arms **31** and **32** to lower the rod **22** and cut down the flow through the spout **21**. If for any reason the metal in the ring drops below the proper level, the float will drop also and raise the rod **22** to increase the flow through the spout **21**. The rod **22**, being thus operatively responsive to even the slightest varaiation in the liquid level in the ring **11**, operates continuously to adjust the flow through the spout **21** to maintain the proper level in the mold.

It will be appreciated that since the spout **21**, rod **22**, and float **38** are constantly in contact with molten aluminum, or molten aluminum alloys, the temeperature of which is considerably in excess of 650 degrees C., they are maintained at approximately the same temperature. It has been found that steel possesses the proper characteristics for use at such temperatures, and in the aluminum industry, the molten metal carrying troughs such as the trough **19** and pouring spouts such as the spout **21**, are commonly formed of this metal. We have found, however, that the rod **22** should not be made of steel. At the temperatures at which the spout **21** and rod **22** are maintained, a steel rod such as the rod **22** tends to stick to the spout **21** when it is brought into contact therewith, and some jarring force is necessary to break it away. Carbon does not exhibit this sticking tendency, and we have found that if the rod **22** is formed of this material it will move into and out of engagement with the steel spout **21** freely, even when both are heated to the temperatures they attain during the pouring operation. Accordingly, the rod **22** of our invention is formed of carbon.

In order for our flow control device to operate, it is necessary that the float **38** and rod **39** be heavy enough to overbalance the weight of the rod **22**. The float **38**, however, must be light enough to float on the molten metal in the ring **11**. We have found that a hollow steel can forms a satisfactory float **38**. Since the float **38** is hollow, and since it is subject to wide temperature variations, it is desirable to provide vent means in the float **38** to prevent undue stresses caused by air pressure therein. This is accomplished by providing an axial venting aperture **43** in the float rod **39** opening at the bottom into the interior of the float **38**. This aperture **43** permits free air movement into and out of the float **38**.

While we have shown the float **38** formed as a hollow steel can, we do not wish to be limited to this construction. The float **38** may also be provided in solid form, and may be formed of carbon as well as steel. Weights, such as those indicated at **44** in the drawings may be used to obtain the proper balance.

It is believed that the nature and advantages of our invention appear clearly from the foregoing.

Having thus described our invention, we claim:

1. In aluminum ingot molding apparatus including a ring mold having an open top and bottom, a vertically movable bottom closure plate below the ring mold, means supporting said closure plate for vertical movement toward and away from said ring mold, a baffle box suspended within the ring mold, and a delivery trough for delivering molten metal through the baffle box to the mold, the improvement in means to control the flow of molten metal from the trough into the mold comprising a conical spout in the bottom of the trough, the walls of said spout converging downwardly, an upright cylindrical rod in the trough in substantial vertical alignment with the spout and extending into the spout, arm means pivotally supporting said rod, a frame resting on the trough above the spout and having means thereon to secure it to the trough, upstanding arm support means projecting upwardly from the frame adjacent to one side of the trough, said arm means being pivoted intermediate the ends thereon on said arm support means at a point spaced from the rod, and float means in the mold supported in floating position by the molten metal in the mold movable vertically in response to changes in the

level of the metal in the mold, said float means being connected to the arm means at the end thereof opposite the rod, said float means being heavier than the rod whereby to overbalance it and to move the rod vertically with respect to the spout to vary the flow of metal through the spout in response to level variations of the molten metal in the mold.

2. In aluminum ingot molding apparatus including a ring mold having an open top and bottom, a vertically movable bottom closure plate below the ring mold, means supporting said closure plate for vertical movement toward and away from said ring mold, a baffle box suspended within the ring mold, and a delivery trough for delivering molten metal through the baffle box to the mold, the improvement in means to control the flow of molten metal from the trough into the mold comprising an elongated tapered outlet in the bottom of the trough above the mold, the outlet decreasing in cross-section downwardly, an upright rod of uniform cross-section in substantial vertical alignment with the outlet, said rod being movable upwardly and downwardly in the outlet to increase and decrease the outlet area, arm means pivotally supporting said rod, a frame resting on the trough above the tapered outlet and having means thereon to secure it to the trough, upstanding arm support means projecting upwardly from the frame adjacent to one side of the trough, said arm means being pivoted intermediate the ends thereof on said arm support means at a point spaced from the rod, and float means in the mold supported in floating position by molten metal in the mold and movable vertically in response to changes in the level of the metal in the mold, said float means being connected to the arm means at the end thereof opposite the rod, the float means overbalancing the rod whereby to move the rod vertically with respect to the outlet to increase and decrease the outlet area in response to downward and upward movement of the float whereby to reduce the flow of metal from the outlet when the level in the mold rises and to increase the flow of metal from the outlet when the level in the mold drops.

3. In aluminum ingot molding apparatus including a ring mold having an open top and bottom, a vertically movable bottom closure plate below the ring mold, means supporting said closure plate for vertical movement toward and away from said ring mold, a baffle box suspended within the ring mold, and a delivery trough for delivering molten metal through the baffle box to the mold, the improvement in means to control the flow of molten metal from the trough into the mold comprising an elongated tapered outlet in the bottom of the trough above the mold, the outlet decreasing in cross-section downwardly, an upright carbon rod of uniform cross-section in substantial vertical alignment with the outlet, said rod being movable upwardly and downwardly in the outlet to increase and decrease the outlet area, arm means pivotally supporting said rod, a frame resting on the trough above the tapered outlet and having means thereon to secure it to the trough, upstanding arm support means projecting upwardly from the frame adjacent to one side of the trough, said arm means being pivoted intermediate the ends thereof on said support arm means at a point spaced from the rod, and float means in the mold supported in floating position by molten metal in the mold and movable vertically in response to changes in the level of the metal in the mold, said float means comprising a hollow metal can and an upright tubular vent pipe fixed to said can, said vent pipe being pivoted to the arm means at the end thereof opposite the rod, the float means overbalancing the rod whereby to move the rod vertically with respect to the outlet to increase and decrease the outlet area in response to downward and upward movement of the float whereby to reduce the flow of metal from the outlet when the level in the mold rises and to increase the flow of metal from the outlet when the level in the mold drops.

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